A Shot in the Dark

It's December 1991, and the scene is a darkened physics lab at New Mexico State University at Las Cruces.

U.S. Army atmospheric scientist Ron Pinnick fires laser bursts at the target—a sheep manure pellet mounted on a pin. Within seconds, a computer screen reveals the pellet's contents.

Pinnick's account of the test to his friend Dean M. Anderson, an animal researcher, caused a light to go on in Anderson's brain: The laser had possibilities for analyzing livestock diets through fecal analysis, he thought.

Anderson has conducted rangeland research for 21 years at the Jornada Experimental Range operated near Las Cruces by USDA's Agricultural Research Service.

Anderson's research has included monitoring food preferences of grazing livestock. And for most of his time at the Jornada, this has required him to analyze animals' fecal material the old-fashioned way: by hand.

"Collecting, preparing, and examining samples under a microscope requires several days," Anderson says. "But the laser takes only a few seconds and is more precise than the human eye." Short bursts of laser light excite the electrons in the sample and cause a unique pattern of light wavelengths to show up on a computer screen as sort of light fingerprints.

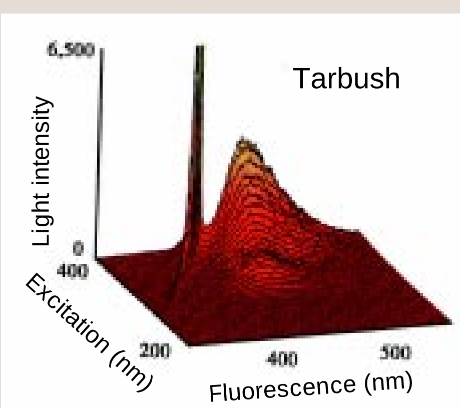
Linking a manure pellet's laser fingerprints to chemical compounds found in specific range plants, Anderson says, could reveal exactly what plants an animal has eaten. And with this kind of dietary knowledge, researchers can recommend how ranchers might better match their animals to their land. For example, if sheep crave a certain plant that goats won't eat, it may make sense to recommend grazing sheep on land with that plant.

He also envisions using the laser analysis system to help spot individual animals with peculiar grazing tastes.

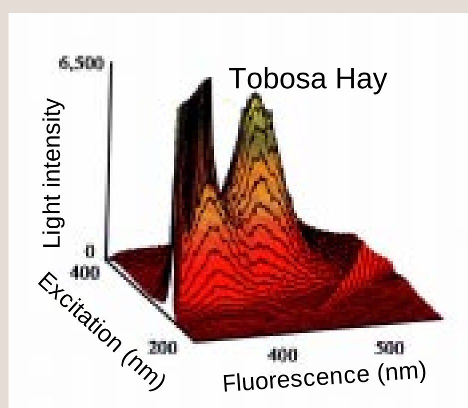
Recently, Anderson teamed up with scientists at Sandia National Laboratory in Albuquerque, New Mexico. These scientists have been evaluating use of alternative light sources that are more readily available and less destructive than lasers, such as xenon lamps. They are testing these for potential civilian and military applications, including detection of volatile organics, bacteria, and transmissible spongiform encephalopathies such as mad cow disease.

DEAN ANDERSON (K8146-1)

Cattle and sheep forage on arid New Mexico rangeland.



To obtain 3-D spectral signatures of different arid rangeland plants, scientists suspend ground samples in a solvent. Electrons in molecules extracted by the solvent are excited by wavelengths of energy between 200 and 400 nanometers (nm) emitted by a xenon lamp. When the light is turned off, energy characteristic of colors in the visible light spectrum is released as fluorescence. Such information will be useful in performing fecal analysis to determine the diet of foraging animals.



One Sunday in November 1991, Pinnick—then working at the nearby White Sands Missile Range—accompanied Anderson for an afternoon on the Jornada. Anderson showed him his traditional technique for collecting and analyzing fecal pellets. The next month, they began firing lasers at sheep pellets.

Since then, Anderson has analyzed more than 100 samples of rangeland plants and animal manure. He and his physics colleagues have found the light fingerprints of many plants including alfalfa, native tobosa grass hay, and a shrub called tarbush.

A colleague at Los Alamos National Laboratory is interested in the potential to monitor the diets of wild deer and elk that graze on federal land. Wild animal diet analysis is important to developing wildlife management strategies.

Anderson's basic technique is simple. He uses chloroform or a saline solution as a solvent to extract samples of plants and manure. Then, in a darkroom, the laser or xenon beam is aimed at the sample. Both the laser and the xenon lamp are connected to electronic equipment for capturing and analyzing light fingerprints.

"We would like to evaluate about 500 rangeland plant species found on the Jornada, starting with the 25 or 30 most popular with our livestock," he says. "We also need to evaluate results in different seasons and with other solvents."—By **Don Comis,** ARS.

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Microwaves To Measure Fruit Maturity

Microwave ovens deserve their reputation for making food preparation easier and faster. But in the future, microwave technology may play a taste-tester role that could mean fresh fruits and vegetables arrive at the table with even more fresh, just-picked flavor.

The microwaves used in this research were at a very low level. The goal wasn't to cook the fruits and vegetables but to measure the properties that influence how electromagnetic waves pass through them.

Two of these properties are well known to physicists and electrical engineers but may be new to others. The dielectric constant tells how a material, living or not, stores electric energy. The dielectric loss factor indicates the ability of a material to absorb energy from an electric field and convert it to heat. As it turns out, there is a correlation between these dielectric properties and the maturity of fresh produce.

"We characterized produce from a microwave viewpoint," says Agricultural Research Service's Stuart Nelson. "We did this to build a database and explore its use as a measure of maturity in peaches."

Nelson, an agricultural engineer, and Roy Forbus, an industrial engineer who is now retired, measured dielectric properties on 23 fruits and vegetables for their database. The scientists got their samples at the same place consumers usually find theirs: the supermarket produce section.

Once they had a database with information about the dielectric properties of fruits and vegetables in general, Nelson and Forbus were ready for a subsequent project. They would look at microwaves as a tool for evaluating ripeness in peaches. This time, the University of Georgia's Agricultural Experiment Station made peaches available to test—Forbus and a student did the picking.

Why look at microwaves as an evaluating tool? They may detect total soluble solids, which are really sugars, in fruits such as peaches. Sugars increase with ripeness. Not enough sugars means your peach was probably taken too soon from the tree.

Preliminary results suggest low-level microwave measurements may lead to development of instruments that growers could use to pinpoint ideal harvesting times. Dielectric properties varied with microwave frequency and the character of the produce itself, such as the fruit's chemical composition and the amount of water in it.

A bonus of this research is that the information could help processors of microwave foods keep the fruit compote in your TV dinner more flavorful during that fast-track heating.—By **Jill Lee,** ARS.

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